



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
15.10.2008 Bulletin 2008/42

(51) Int Cl.:
F02M 21/02 (2006.01) F02M 51/06 (2006.01)
F02M 53/04 (2006.01)

(21) Application number: **07707504.2**

(86) International application number:
PCT/JP2007/051272

(22) Date of filing: **26.01.2007**

(87) International publication number:
WO 2007/088790 (09.08.2007 Gazette 2007/32)

(84) Designated Contracting States:
DE IT NL PL

(72) Inventor: **NAKAJIMA, Yoji**
Kakuda-shi, Miyagi 981-1505 (JP)

(30) Priority: **02.02.2006 JP 2006025914**

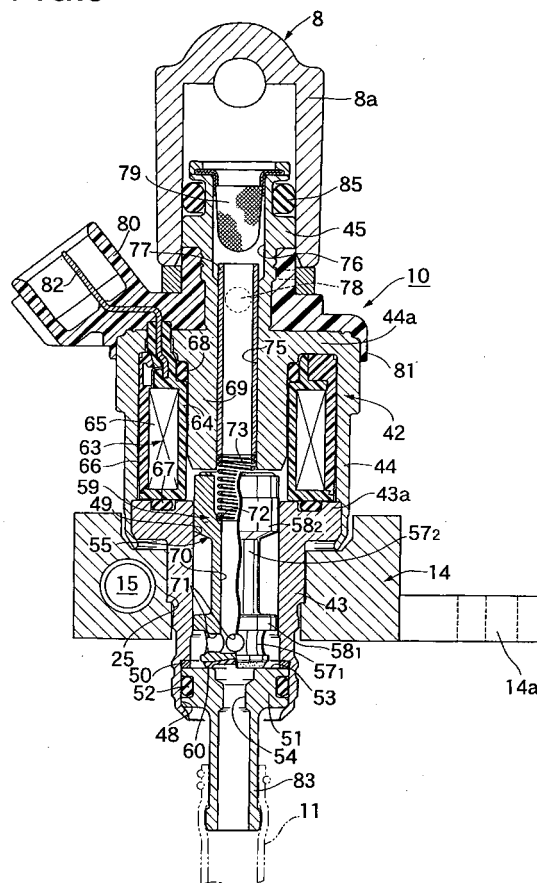
(74) Representative: **Prechtel, Jörg et al**
Weickmann & Weickmann
Patentanwälte
Postfach 86 08 20
81635 München (DE)

(71) Applicant: **Keihin Corporation**
Tokyo 163-0539 (JP)

(54) **ENGINE GAS FUEL SUPPLY APPARATUS**

(57) An engine gas fuel supply apparatus is provided that includes a gas fuel injection valve (10) formed from a valve housing (42) having at one end a fuel inlet hole (76) communicating with a gas fuel tank (9), a nozzle member (51) provided at the other end of the valve housing (42) and having a valve seat (53) and a nozzle hole (54) running through a central part of this valve seat (53), and a valve body (55) slidably fitted into a guide hole (49) of the valve housing (42) and via one end face opening and closing the nozzle hole (54) in cooperation with the valve seat (53), wherein a heating chamber (15) for heating the valve seat (53) and the periphery of the guide hole (49) is disposed in the area around the valve housing (42), and cooling, water for an engine (E) is made to pass through the heating chamber (15) as a heat source therefor. This enables the valve seat and a sliding part of the valve body of the gas fuel injection valve to be heated at an early stage after starting the engine, the viscosity of oil attached thereto to be decreased, and the gas fuel injection valve to be operated properly at an early stage.

FIG.5



Description

TECHNICAL FIELD

[0001] The present invention relates to an engine gas fuel supply apparatus for supplying a gas such as LPG or CNG to an engine as a fuel, and particularly to an improvement of an engine gas fuel supply apparatus that includes a gas fuel injection valve formed from a valve housing having at one end a fuel inlet hole communicating with a gas fuel tank, a nozzle member provided at the other end of the valve housing and having a valve seat and a nozzle hole running through a central part of this valve seat, a valve body slidably fitted into a guide hole of the valve housing and via one end face opening and closing the nozzle hole in cooperation with the valve seat, a coil supported on the valve housing, a fixed core coupled to the valve housing and disposed inside the coil so as to face the other end face of the valve body, and a return spring provided in a compressed state between the fixed core and the valve body and urging the valve body toward the valve seat side, so that when the coil is energized, the fixed core attracts the valve body thereby separating it from the valve seat and gas fuel is supplied to the engine from the nozzle hole.

BACKGROUND ART

[0002] Such an engine gas fuel supply apparatus is already known, as disclosed in Patent Publication 1 below.

Patent Publication 1: Japanese Utility Model Registration Application Laid-open No. 5-78956

DISCLOSURE OF INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0003] Conventionally, gas fuel with which a gas fuel tank of such an engine gas fuel supply apparatus is charged is contaminated to some degree with lubricating oil within a compressor used for the charging. Because of this, fuel supplied from the gas fuel tank to a gas fuel injection valve is slightly contaminated with the oil, and the oil might become attached to a valve seat of the gas fuel injection valve, a sliding face of a valve body, etc. The attached oil slows down movement of the valve body, particularly when the engine is cold, and the oil viscosity increases, thus impeding operation of the engine.

[0004] In a general gas fuel supply apparatus, when the engine is cold the engine is started using gasoline fuel, gas fuel is heated utilizing engine cooling water by means of a vaporizer, and the engine is run by switching over to the gas fuel after the temperature of the cooling water reaches a temperature that enables the gas fuel to be vaporized. However, unless the gas fuel injection valve reaches a high temperature, operation of the valve body is impaired due to the high viscosity of the attached

oil.

[0005] Operating the engine with gasoline fuel until it attains a hot state in which the viscosity of the attached oil decreases and the operation of the valve body is not impeded could be considered, but since it takes a considerable time to attain such a hot state, the consumption of gasoline fuel increases.

[0006] The engine gas fuel supply apparatus disclosed in Patent Publication 1 is provided with an evaporator for heating and vaporizing fuel from the gas fuel tank utilizing engine cooling water, but even if fuel is heated by this evaporator, unless the gas fuel injection valve reaches a high temperature, since the temperature of the oil attached to the interior of the gas fuel injection valve remains low and the viscosity thereof is high, the operation of the valve body is impeded.

[0007] The present invention has been accomplished in the light of such circumstances, and it is an object thereof to provide an engine gas fuel supply apparatus of the above type that enables a valve seat and a sliding part of a valve body of a gas fuel injection valve to be heated at an early stage after starting the engine, the viscosity of oil attached thereto to be decreased, and the gas fuel injection valve to be operated properly at an early stage.

MEANS FOR SOLVING THE PROBLEMS

[0008] In order to attain the above object, according to a first aspect of the present invention, there is provided an engine gas fuel supply apparatus comprising a gas fuel injection valve formed from a valve housing having at one end a fuel inlet hole communicating with a gas fuel tank, a nozzle member provided at the other end of the valve housing and having a valve seat and a nozzle hole running through a central part of this valve seat, a valve body slidably fitted into a guide hole of the valve housing and via one end face opening and closing the nozzle hole in cooperation with the valve seat, a coil supported on the valve housing, a fixed core coupled to the valve housing and disposed inside the coil so as to face the other end face of the valve body, and a return spring provided in a compressed state between the fixed core and the valve body and urging the valve body toward the valve seat side, so that when the coil is energized, the fixed core attracts the valve body thereby separating the valve body from the valve seat and gas fuel is supplied to an engine from the nozzle hole, characterized in that a heating chamber for heating the valve seat and the periphery of the guide hole is disposed in the area around the valve housing, and cooling water for the engine is made to pass through the heating chamber as a heat source therefor.

[0009] According to a second aspect of the present invention, in addition to the first aspect, in order to hold the gas fuel injection valve, an injection valve holder is provided, the injection valve holder fitting onto the outer periphery of the valve housing in the area around the

valve seat and the guide hole, and the heating chamber is formed in the valve holder.

[0010] According to a third aspect of the present invention, in addition to the second aspect, the injection valve holder is formed so as to hold a plurality of the gas fuel injection valves, and the heating chamber, which is continuous and used in common for the plurality of gas fuel injection valves, is formed in the valve holder.

EFFECTS OF THE INVENTION

[0011] In accordance with the first aspect of the present invention, the inner peripheral face of the guide hole, the outer peripheral face of the valve body, and the area around the valve seat of the gas fuel injection valve can be heated effectively by the heating chamber through which cooling water of the engine passes, the oil attached thereto is therefore also heated, the viscosity thereof is decreased, and it is thereby possible to prevent malfunctioning of the gas fuel injection valve caused by the attached oil.

[0012] In accordance with the second aspect of the present invention, since the heating chamber is formed in the valve holder, which supports the gas fuel injection valve, not only is it unnecessary to provide a heating member used exclusively therefor and specially having a heating chamber, but it is also possible to heat effectively the valve seat of the gas fuel injection valve and the periphery of the guide hole, thereby reliably preventing malfunctioning of the gas fuel injection valve caused by attached oil.

[0013] In accordance with the third aspect of the present invention, it is possible, with the continuous heating chamber provided in the common valve holder supporting the plurality of gas fuel injection valves, to heat the valve seats and the periphery of the guide holes of the plurality of gas fuel injection valves at a stroke, thus simplifying the heating structure therefor and thereby contributing to a reduction in cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

[FIG. 1] FIG. 1 is a schematic diagram of an engine fuel supply system related to an embodiment of the present invention (first embodiment).

[FIG. 2] FIG. 2 is a perspective view of an area around a gas fuel injection valve in the same system (first embodiment).

[FIG. 3] FIG. 3 is a view from arrow 3 in FIG. 2 (first embodiment).

[FIG. 4] FIG. 4 is a sectional view along line 4-4 in FIG. 3 (first embodiment).

[FIG. 5] FIG. 5 is an enlarged sectional view along line 5-5 in FIG. 4 (first embodiment).

EXPLANATION OF REFERENCE NUMERALS AND SYMBOLS

[0015]

E Engine
4 Gas fuel supply apparatus
9 Gas fuel tank
10 Gas fuel injection valve
14 Valve holder
13 Water jacket
15 Heating chamber (second heating chamber)
42 Valve housing
49 Guide hole
51 Nozzle member
53 Valve seat
54 Nozzle hole
55 Valve body
65 Coil
69 Fixed core
73 Return spring

BEST MODE FOR CARRYING OUT THE INVENTION

[0016] A mode for carrying out the present invention is explained below by reference to a preferred embodiment of the present invention shown in the attached drawings.

[0017] Embodiment 1

Firstly, in FIG. 1, a multicylinder engine E has a plurality, corresponding to the number of cylinders, of intake pipes Ea (only one thereof is shown in FIG. 1) connected to a side face of a cylinder head thereof, and these intake pipes Ea are equipped with gasoline fuel injection valves 1 capable of injecting gasoline fuel toward corresponding cylinders and with gas fuel injection tubes 2 similarly injecting gas as a fuel toward the corresponding cylinders. Connected to the gasoline fuel injection valves 1 is a known gasoline fuel supply apparatus 3, and connected to the gas fuel injection tube 2 is a gas fuel supply apparatus 4 of the present invention for supplying a gas such as LPG or CNG as a fuel.

[0018] This gas fuel supply apparatus 4 includes a gas fuel tank 9 (charged with LPG liquefied gas in the illustrated example), a vaporizer 6 connected to a fuel outlet of the gas fuel tank 9 via a first fuel passage 5, a fuel distribution pipe 8 connected to a fuel outlet of the vaporizer 6 via a second fuel passage 7 and, connected to a plurality of distribution opening tubes 8a of the fuel distribution pipe 8, the same number of gas fuel injection valves 10 as there are fuel injection tubes 2, fuel outlets of these gas fuel injection valves 10 being connected to the fuel injection tubes 2 via a plurality of pipes 11. The vaporizer 6 reduces the pressure of high pressure liquefied fuel fed out from the gas fuel tank 9 and heats and vaporizes it, and includes a first heating chamber 12 for

carrying out the heating.

[0019] Furthermore, the plurality of gas fuel injection valves 10 are supported in a row on a common valve holder 14 having a bracket 14a supported at an appropriate position on the engine E; this valve holder 14 includes a common second heating chamber 15 (see FIG. 4) for heating a predetermined section, which is described later, of all of the gas fuel injection valves 10, and a hot water passage is formed between the first and second heating chambers 12 and 15 and a water jacket 13 for cooling the engine E, hot water that has absorbed heat in the water jacket 13 being circulated through the hot water passage. This hot water passage is formed from a first hot water passage 16 extending from the water jacket 13 and connected to a hot water inlet tube 12a of the vaporizer 6, a second hot water passage 17 extending from a hot water outlet tube 12b of the vaporizer 6 and connected to a hot water inlet tube 15a of the valve holder 14, and a third hot water passage 18 extending from a hot water outlet tube 15b of the valve holder 14 and reaching the water jacket 13.

[0020] The first fuel passage 5 is provided with a fuel cutoff valve 31, and the third hot water passage 18 is provided with a hot water cutoff valve 32. Inputted into an electronic control unit 20 for controlling operation of the gasoline fuel injection valves 1, the gas fuel injection valves 10, the fuel cutoff valve 31, the hot water cutoff valve 32, etc. are output signals from an engine temperature sensor 21, for detecting an engine temperature, that is, a water temperature T_e within the water jacket 13 of the engine E, a throttle sensor 22 for detecting a degree of opening T_h of a throttle valve of the engine E, an engine rotational speed sensor 23 for detecting an engine rotational speed N_e , etc.

[0021] The gas fuel injection valve 10 is now explained in detail by reference to FIG. 5. This gas fuel injection valve 10 includes a valve housing 42 formed from a cylindrical first housing part 43, a cylindrical second housing part 44, with a larger diameter than that of the first housing part 43, having a front end part joined by swaging to a flange 43a at the rear end of the first housing part 43, and a cylindrical third housing part 45, with a smaller diameter than that of the second housing part 44, provided so as to be connected integrally to a rear end wall 44a of the second housing part 44, and the first to third housing parts 3 to 5 are all formed from a magnetic material.

[0022] The first housing part 43 has formed coaxially therein a mounting hole 48 opening at the front end and a guide hole 49 opening at the rear end and having a smaller diameter and a longer length than the mounting hole 48, and an annular shim 50 and a disc-shaped nozzle member 51 are fitted into the mounting hole 48 in sequence and secured by swaging the front edge of the first housing part 43 inward. In this arrangement, an annular sealing member 52 is fitted around the outer periphery of the nozzle member 51, the annular sealing member 52 being in intimate contact with an inner pe-

ripheral face of the mounting hole 48. The annular shim 50 is for adjusting the position at which the nozzle member 51 is fitted by selection of its thickness.

[0023] The guide hole 49 slidably houses and retains a valve body 55. This valve body 55 is formed from a plunger 59 formed by coaxially and integrally connecting, from the front end side, a flange portion 56, a short axial portion 57₁, a first journal portion 58₁, a long axial portion 57₂, and a second journal portion 58₂, and a rubber seating member 60 joined by baking to a front end face of the flange portion 56; seating the seating member 60 on the valve seat 53 and separating it therefrom enables the nozzle hole 54 to be opened and closed. The plunger 59 is made of a magnetic material so that it also serves as a movable core.

[0024] In the plunger 59, the short axial portion 57₁ and the long axial portion 57₂ are formed so as to have a smaller diameter than that of the first and second journal portions 58₁ and 58₂, and the first and second journal portions 58₁ and 58₂ are both slidably supported in the guide hole 49.

[0025] The second housing part 44 houses a coil assembly 63. This coil assembly 63 is formed from a bobbin 64, a coil 65 wound around the outer periphery of the bobbin 64, and a resin molded part 66 for sealing the coil 65 in the bobbin 64, and an annular sealing member 67 is disposed between the bobbin 64 and the flange 43a of the first housing part 43.

[0026] A cylindrical fixed core 69 fitted into an inner peripheral face of the bobbin 64 is formed integrally with a rear end wall 44a of the second housing part 44, and a sealing member 68 for sealing mating parts thereof is disposed between the bobbin 64 and the fixed core 69. The plunger 59 has its rear end part projecting into the bobbin 64 so as to face a front end face of the fixed core 69.

[0027] The plunger 59 is provided with a lengthwise hole 70 extending from its rear end face and finishing before the flange portion 56, and a plurality of transverse holes 71 providing communication between the lengthwise hole 70 and an outer peripheral face of the short axial portion 57₁. In this arrangement, an annular spring seat 72 facing the fixed core 69 side is formed partway along the lengthwise hole 70.

[0028] A support hole 75 communicating with the lengthwise hole 70 and extending from the fixed core 69 to the front half of the third housing part 45 is formed in central parts thereof, and an inlet hole 76 communicating with the support hole 75 and having a larger diameter than that thereof is provided in the rear half of the third housing part 45. A pipe-shaped retainer 77 is inserted into the support hole 75, the retainer 77 supporting between itself and the spring seat 72 a return spring 73 that urges the valve body 55 toward the valve seat 53 side, and the retainer 77 is secured to the third housing part 45 by swaging the outer periphery of the third housing part 45 after a set load of the return spring 73 has been adjusted by changing the insertion depth of the retainer

77. Reference numeral 78 denotes a swaged portion. A fuel filter 79 is fitted into the inlet hole 76.

[0029] A resin molded part 81 is formed so as to extend from a rear end part of the second housing part 44 to the front half of the third housing part 45 and cover the outer peripheral faces thereof, the resin molded part 81 integrally having a coupler 80 on one side, and the coupler 80 retains a current-carrying terminal 82 connected to the coil 65.

[0030] A structure for mounting each gas fuel injection valve 10 and the fuel distribution pipe 8 on the valve holder 14 is now explained by reference to FIG. 2 to FIG. 5.

[0031] A plurality of mounting holes 25 are formed in the valve holder 14 so as to correspond to the plurality of gas fuel injection valves 10, and the first housing 43 of the gas fuel injection valve 10 corresponding to each mounting hole 25 is fitted thereinto, the depth to which it is fitted being restricted by the front end of the second housing 44 abutting against the valve holder 14. An inner peripheral face of the mounting hole 25 is fitted around an outer peripheral face of the first housing 43 in the proximity of the guide hole 49 and the valve seat 53, and the second heating chamber 15 is formed in the valve holder 14 so as to be as close to the inner peripheral face of the mounting hole 25 as possible. Therefore, when the valve holder 14 is heated by hot water introduced into the second heating chamber 15, the inner peripheral face of the guide hole 49 and the area around the valve seat 53 are heated particularly effectively.

[0032] Furthermore, a rear end part of the third housing part 45 is fitted into the corresponding distribution opening tube 8a of the fuel distribution pipe 8 via a sealing member 85. A pair of support bosses 26 are formed on the fuel distribution pipe 8 so as to project between adjacent distribution opening tubes 8a, stud bolts 27 and 27 are implanted in end faces of these support bosses 26 and 26, these stud bolts 27 and 27 are disposed so as to run through the valve holder 14, distance collars 28 and 28 are disposed between the support bosses 26 and 26 and the valve holder 14, and the fuel distribution pipe 8 is secured to the valve holder 14 by screwing and tightening nuts 29 and 29 onto the lower ends of the stud bolts 27 and 27.

[0033] Moreover, a joint pipe 83 is formed integrally with a front end face of the nozzle member 51, the interior of the joint pipe 83 communicating with the nozzle hole 54, and this joint pipe 83 is connected to the fuel injection tube 2 via a pipe 11.

[0034] The operation of this embodiment is now explained.

[0035] When the engine E is cold, the electronic control unit 20 operates the gasoline fuel supply apparatus 3 so that fuel is injected from the gasoline fuel injection valves 1 into the intake pipes Ea, thus starting and warming up the engine E.

[0036] During warming up of the engine E, the electronic control unit 20 controls the fuel cutoff valve 31 so that it is in a valve open state and the hot water cutoff

valve 32 so that it is in a valve open state. Therefore, since cooling water for the engine E circulates from the water jacket 13 through the first heating chamber 12 of the vaporizer 6 and the second heating chamber 15 of the valve holder 14 to the water jacket 13, when warming up of the engine E is nearly completed, cooling water that has absorbed heat in the water jacket 13 attains a high temperature, and the valve holder 14 and the vaporizer 6 thereby attain a predetermined temperature.

[0037] The electronic control unit 20 accordingly stops operation of the gasoline fuel supply apparatus 3, switches to operation of the gas fuel supply apparatus 4, opens the fuel cutoff valve 31, and controls the passage of current through the coils 65 of the gas fuel injection valves 10.

[0038] Liquefied gas fuel fed out from the gas fuel tank 9 due to opening of the fuel cutoff valve 31 is heated and vaporized in the vaporizer 6, then supplied to the fuel distribution pipe 8, and distributed from the plurality of distribution opening tubes 8a to the plurality of gas fuel injection valves 10.

[0039] In each gas fuel injection valve 10, when the coil 65 is in a de-energized state, the valve body 55 is pressed forward by the urging force of the return spring 73, thus seating the seating member 60 on the valve seat 53. In this state, gas fuel fed to the distribution opening tube 8a flows into the inlet hole 76 of the valve housing 42 and is filtered by the fuel filter 79, passes through the interior of the pipe-shaped retainer 77 and the lengthwise hole 70 and transverse holes 71 of the valve body 55, and is held in readiness within the guide hole 49.

[0040] When the coil 65 is energized by the passage of current, a magnetic flux thus generated runs in sequence through the fixed core 69, the second housing part 44, the flange 43a, and the valve body 55, and the valve body 55 is attracted toward the fixed core 69 against the set load of the return spring 73 and separated from the valve seat 53 by the magnetic force. Consequently, the gas fuel held in readiness in the guide hole 49 passes through the valve seat 53, the nozzle hole 54 and the pipes 11, and is injected into the intake pipe Ea of the engine E from the gas fuel injection tube 2, and the amount of fuel injected is controlled by the valve opening time of the valve body 55.

[0041] As described above, since fuel supplied from the gas fuel tank 9 to the gas fuel injection valve 10 is contaminated to some degree with oil, the oil contained in the gas fuel becomes attached to the inner peripheral face of the guide hole 49, the outer peripheral face of the valve body 55, the valve seat 53, etc. when the gas fuel passes through the guide hole 49 and the valve seat 53, but since as described above the valve holder 14 supporting the gas fuel injection valves 10 is heated by cooling water for the engine E, the valve holder 14 heats effectively the inner peripheral face of the guide hole 49, the outer peripheral face of the valve body 55, and the area around the valve seat 53 in proximity to the second heating chamber 15, and the oil attached thereto is also

heated. As a result, since the viscosity of the attached oil decreases, it is possible to prevent malfunction of the gas fuel injection valve 10 due to the attached oil.

[0042] As described above, forming the second heating chamber 15 for heating the gas fuel injection valve 10 in the valve holder 14, which supports the gas fuel injection valve 10, means that it is unnecessary to provide a heating member used exclusively therefor and specially having a heating chamber.

[0043] Moreover, since the second heating chamber 15 is formed in the valve holder 14 along the direction in which the plurality of gas fuel injection valves 10 are arranged in order to heat the valve seat 53 and the periphery of the guide hole 49 of the plurality of gas fuel injection valves 10 at a stroke, the heating structure therefor can be simplified, and consequently the cost thereof can be reduced.

[0044] When the electronic control unit 20 determines from an output signal from the engine temperature sensor 21 that the water temperature of the water jacket 13 has attained a predetermined value or greater, the electronic control unit 20 puts the hot water cutoff valve 32 in a valve closed state, thus suppressing excessive increase in the temperature of the second heating chamber 15 and thereby preventing the gas fuel injection valve 10 from being overheated.

[0045] The present invention is not limited to the above-mentioned embodiment, and may be modified in a variety of ways as long as the modifications do not depart from the spirit and scope thereof.

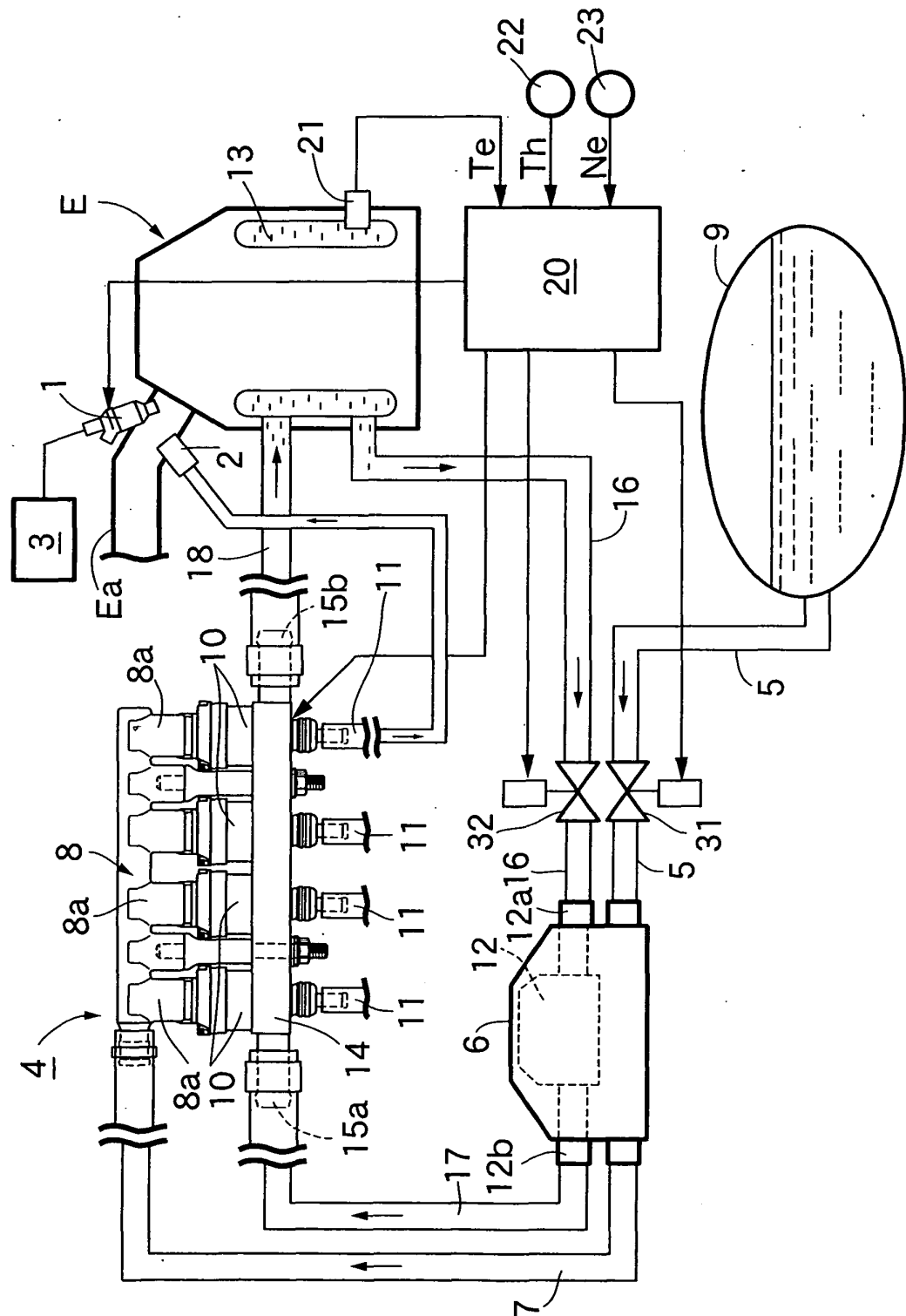
Claims

1. An engine gas fuel supply apparatus comprising a gas fuel injection valve (10) formed from a valve housing (42) having at one end a fuel inlet hole (76) communicating with a gas fuel tank (9), a nozzle member (51) provided at the other end of the valve housing (42) and having a valve seat (53) and a nozzle hole (54) running through a central part of this valve seat (53), a valve body (55) slidably fitted into a guide hole (49) of the valve housing (42) and via one end face opening and closing the nozzle hole (54) in cooperation with the valve seat (53), a coil (65) supported on the valve housing (42), a fixed core (69) coupled to the valve housing (42) and disposed inside the coil (65) so as to face the other end face of the valve body (55), and a return spring (73) provided in a compressed state between the fixed core (69) and the valve body (55) and urging the valve body (55) toward the valve seat (53) side, so that when the coil (65) is energized, the fixed core (69) attracts the valve body (55) thereby separating the valve body (55) from the valve seat (53) and gas fuel is supplied to an engine (E) from the nozzle hole (54),
characterized in that a heating chamber (15) for

heating the valve seat (53) and the periphery of the guide hole (49) is disposed in the area around the valve housing (42), and cooling water for the engine (E) is made to pass through the heating chamber (15) as a heat source therefor.

2. The engine gas fuel supply apparatus according to Claim 1, wherein in order to hold the gas fuel injection valve (10), an injection valve holder (14) is provided, the injection valve holder (14) fitting onto the outer periphery of the valve housing (42) in the area around the valve seat (53) and the guide hole (49), and the heating chamber (15) is formed in the valve holder (14).
3. The engine gas fuel supply apparatus according to Claim 2, wherein the injection valve holder (14) is formed so as to hold a plurality of the gas fuel injection valves (10), and the heating chamber (15), which is continuous and used in common for the plurality of gas fuel injection valves (10), is formed in the valve holder (14).

FIG.1



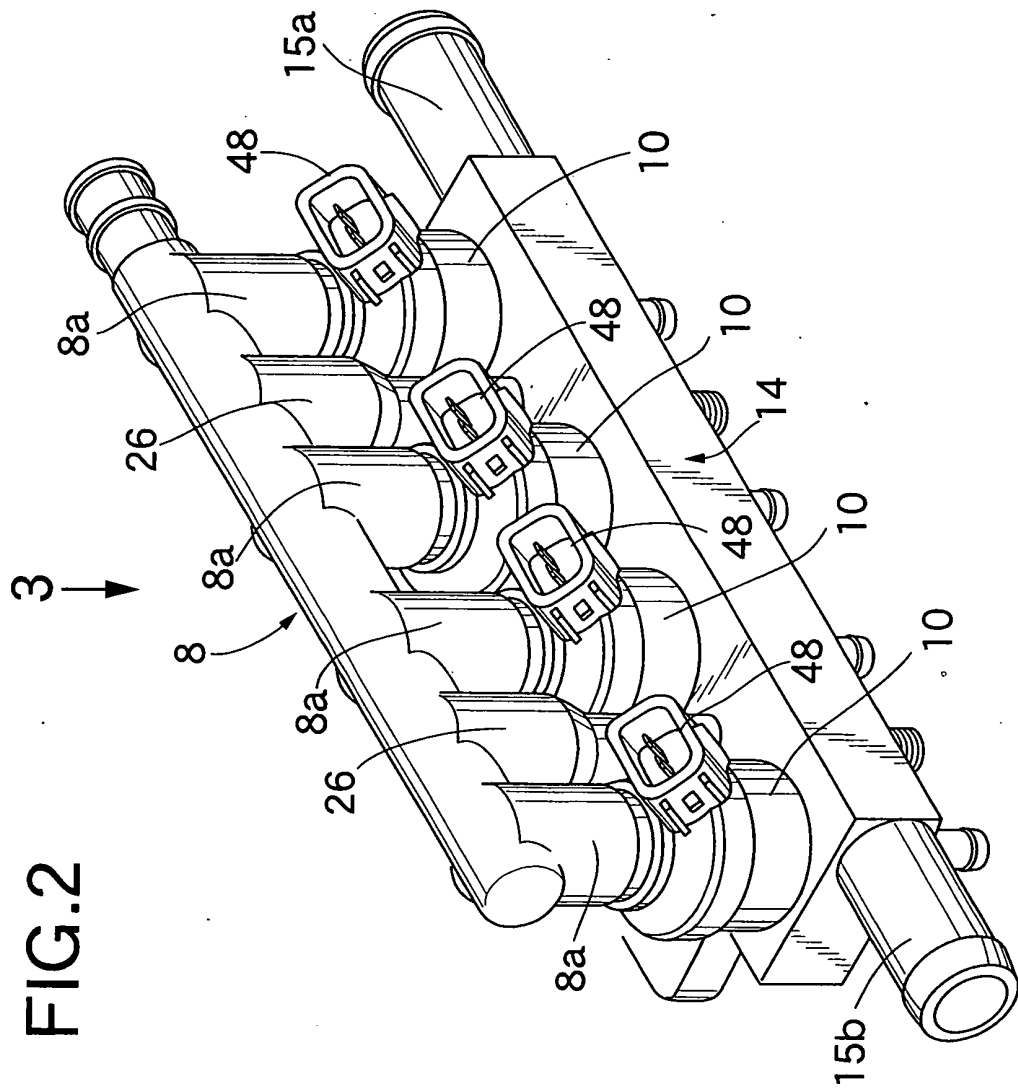


FIG.3

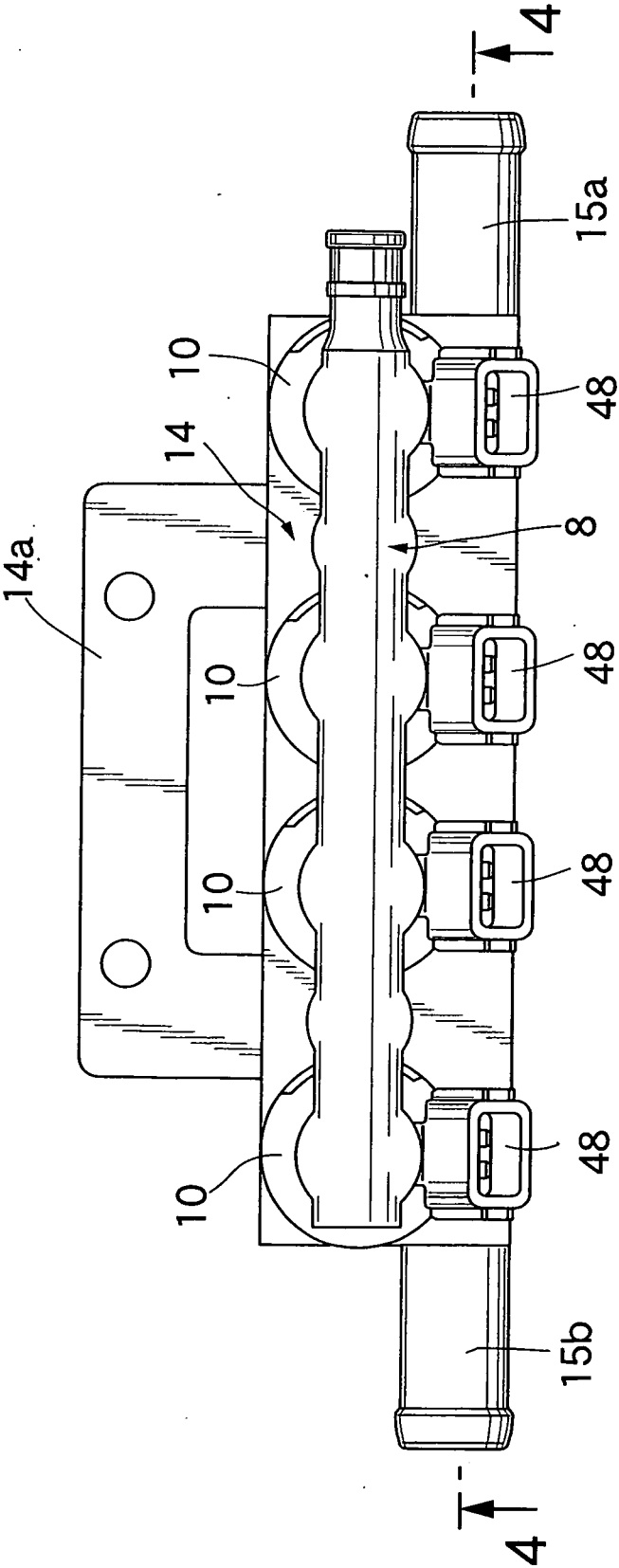


FIG.4

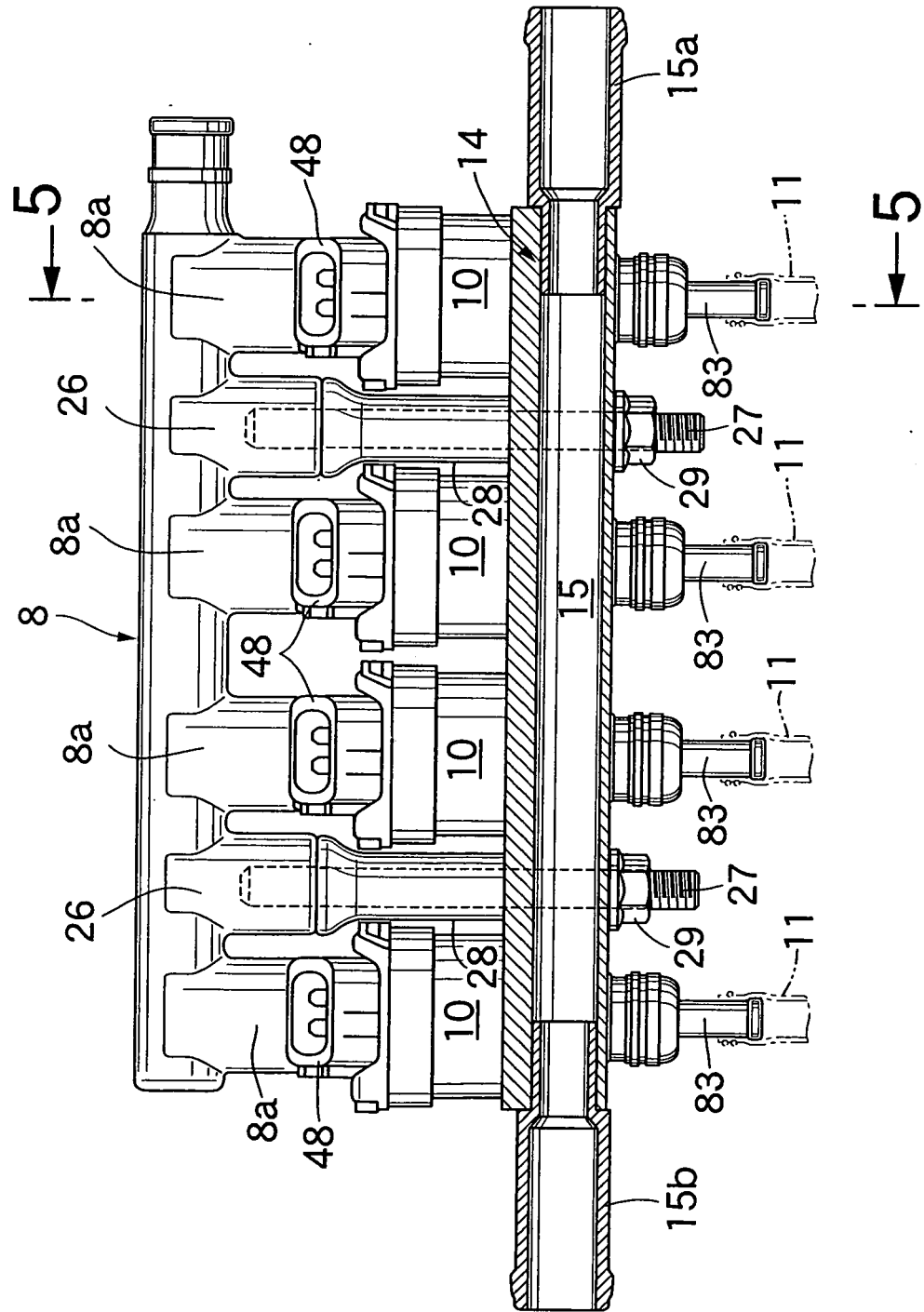
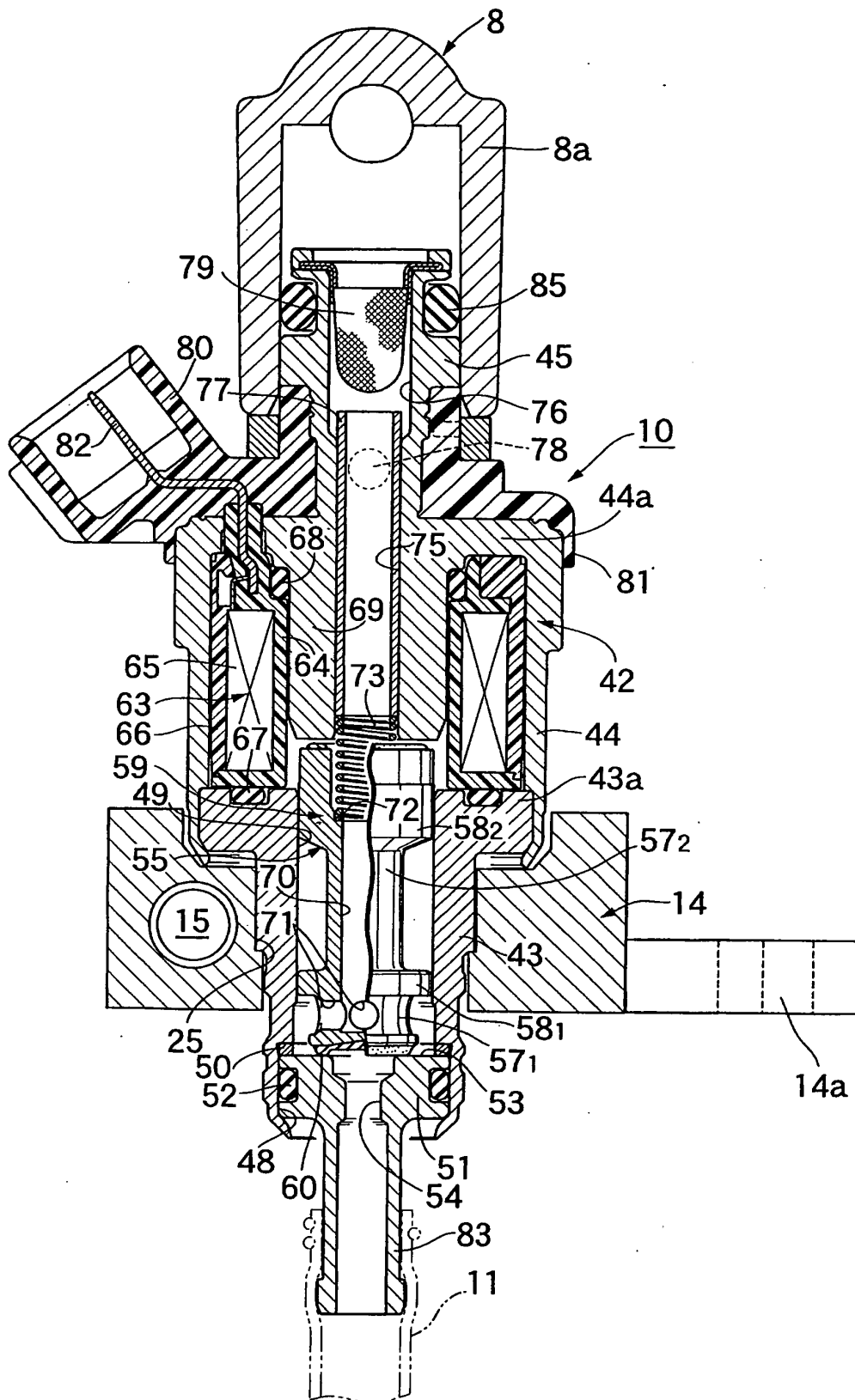


FIG.5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/051272

A. CLASSIFICATION OF SUBJECT MATTER

F02M21/02(2006.01) i, F02M51/06(2006.01) i, F02M53/04(2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F02M21/02, F02M51/06, F02M53/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2000-345916 A (Toyota Motor Corp.), 12 December, 2000 (12.12.00), Par. Nos. [0002] to [0009], [0014] to [0023]; Fig. 1 (Family: none)	1-3
Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 17820/1992 (Laid-open No. 78956/1993) (Nissan Diesel Motor Co., Ltd.), 26 October, 1993 (26.10.93), Par. No. [0010]; Fig. 1 (Family: none)	1-3

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
12 April, 2007 (12.04.07)Date of mailing of the international search report
24 April, 2007 (24.04.07)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 5078956 A [0002]